



Integrated Petroleum Technologies, Inc.

December 6, 2014

Mr. Pat O'Brien
East Cherry Creek Valley Water and Sanitation District
6201 South Gun Club Road
Aurora, Colorado 80016

RE: EPA Falloff Test Analysis
EPA UIC Permit CO12143-08425
ECCV DI-1 Injection Well
SHL: 540' FSL, 660' FWL
Section 1 T1S R66W
Adams County, Colorado

Dear Mr. O'Brien:

The EPA pressure falloff test analysis is attached for the ECCV DI-1 Injection well in Adams County, Colorado.

IPT appreciates the opportunity to work with you and East Cherry Creek Valley Water and Sanitation District on this analysis. Please do not hesitate to call if you have any questions or require any additional assistance.

Sincerely,

Clayton L. Doke
Senior Petroleum Engineer



1) **Company Name & Address**

East Cherry Creek Valley Water and Sanitation District
6201 South Gun Club Road
Aurora, Colorado 80016

2) **Test Well Name & Location**

ECCV DI-1 Injection Well
SW/4 SW/4 Section 1 T1S R66W
Adams County, Colorado

3) **Facility Contact Person**

Clint Carter

Office: (720) 685-3367
Mobile: (303) 901-7681

Report Prepared by:

Clayton Doke

Integrated Petroleum Technologies, Inc.
405 Urban Street, Suite 401
Lakewood, CO 80228
Office: (303) 216-0703

4) **Openhole Log**

See attached Triple Combo Log run 07/27/10

Injection Zones: Lyons, Wolfcamp, Amazon, Council Grove and Missouri formations

5) **Well Schematic**

See attached well schematic diagram

Wellbore radius: 0.365'

Completed interval depths: Lyons: 9,152' – 9,253'

Wolfcamp: 9,558' – 9,582'

Amazon: 9,664' – 9,698'

Council Grove: 9,702' – 9,706'

Missouri: 10,002' – 10,038'

Type of completion: Cased & cemented, injection under a packer set at 9,049' via 4-1/2" tubing

6) **Date of Fill Depth**

Current fill depth is 10,160', recorded on April 21, 2012, which is 122' below the bottom perforation.



7) Offset well information

The nearest well completed in the same formation is the Suckla Farms Injection Well #1, SENW Section 10-1N-67W, operated by KP Kauffman Company Inc. This well is completed in the Lyons formation and is approximately 9 miles to the north-west. No interference between these two wells is assumed to occur for the purposes of this analysis.

8) Chronological Listing of Daily Testing Activities

Injection averaged 7,760 bbls per day from 6th-Sept to 30th-Sept

09/30/14	Injection began at 341.42 BWPH Average
10/03/14	Injection stopped; 24,923.5 BW injected
10/15/14	Normal injection operations commence (total SI = 285.95 hrs)

9) Electronic Submission of Raw Data

The attached CD contains a file of raw time, rate, tubing pressure, annular pressure and wellhead temperature data from Sept 6, 2014 to Oct 15, 2014.

10) Tabular Summary of Injection Rates

A tabular summary of injection rates for preceding the falloff test is included along with a Rate vs. Time plot. The raw rate-time data is included in the .csv file on the attached CD.

11) Offset Well Rate Information

As discussed above, no offset well rate information is considered to be useful in this test analysis.

12) Hard Copy of Time and Pressure Data

A hard copy of the tabular summary for the raw time, rate, pressure & temperature data from the testing period was not included in this report due to its length. A plot of Rate, Tubing Pressure, Annular Pressure and Temperature vs Time has been included. The .csv file containing this data is on the attached CD.



13) Pressure Gauge and Flowmeter Information

Endress+Hauser Pressure Gauge:

Instrument: Cerabar S PMP71

SN: E904681509C

Installed at: Surface (Tubing)

Pressure accuracy: 0.075% of set span (+/- 4.50 psi)

Measurement range: 0 to 6,000 psi gauge

Calibration range: 0 to 6,000 psi gauge

Last calibration check: Oct 16, 2014

Endress+Hauser Pressure Gauge:

Instrument: Cerabar S PMP71

SN: F400031509C

Installed at: Surface (Annulus)

Pressure accuracy: 0.075% of set span (+/- 0.15 psi)

Measurement range: 0 to 200 psi gauge

Calibration range: 0 to 200 psi gauge

Last calibration check: Oct 16, 2014

Calibration certificates for both gauges are attached.

Below is the Endress+Hauser Recommended Calibration Interval for Pressure Devices:

- Directly mounted pressure measurement devices which operate with stable process conditions with the instrument located inside a building or plant (Normal conditions) should be calibrated every 4-6 years.
- If the same process conditions apply but the device is located outside then reduce the calibration interval to 1-4 years dependent on the extremes of the environment.
- If the device is fitted with a diaphragm seal then reduce the calibration period by a factor of two or alternately consider an interim inspection of the seal to verify its integrity.
- If the process pressure continually varies, or over pressure is a possibility then reduce the calibration period by a factor of two.

Based upon the last calibration date and the falloff test date, the gauges are within the manufacturer's recommended calibration interval.



Endress+Hauser Flowmeter:
Instrument: Promag 53W
SN: EA06FA16000
Maximum measured error: +/-0.2%
Last calibration check: Oct 16, 2014

Calibration certificate for flowmeter is attached.

Below is the Endress+Hauser Recommended Calibration Interval for Electromagnetic Liquid Flowmeters:

- Assuming a homogenous process liquid at a stable temperature with the instrument working under normal ambient conditions then re-calibrate every 4-6 years.
- If the normal process conditions apply but the device is operating in hostile ambient conditions then reduce the calibration interval to 1-4 years dependent on the extremes of the environment.
- If the process fluid conditions are heavy (during cleaning in place for example) or the device is operated at the extremes of its temperature limits then re-calibration on an annual basis may need to be considered.
- If the process fluid is abrasive or corrosive then the calibration intervals should be reduced accordingly.
- The use of electronic verification tools, to check the sensor status and electronics performance can be applied on a 1- 2 year basis. If this is combined with maintenance and inspection routines then the calibration intervals suggested above can be extended by a factor of two.

Based upon the last calibration date and the falloff test date, the gauge is within the manufacturer's recommended calibration interval.

14) **General Test Information**

Injection commenced Sept 30, 2014 3:12 PM and ceased Oct 3, 2014 4:03 PM.
Surface pressure monitored from Oct 3, 2014 4:03 PM to Oct 15, 2014 1:59 PM.

Time synchronization: All data is from surface measurements and were recorded simultaneously. As such, no synchronization was necessary.

Location of shut-in valve: Well was shut in at the wellhead.



15) Reservoir Parameters

Water specific gravity (-):	1.005	(sample analysis by hydrometer)
Water viscosity (μ):	0.1947 cp	(correlation)
Porosity (ϕ):	6%	(measured-density log porosity)
Total Compressibility (ct):	$6.726 \cdot 10^{-6} \text{ psi}^{-1}$	(correlation)
Formation Volume Factor:	1.069 rb/stb	(correlation)

Initial formation reservoir pressure: From the attached semi-log Diagnostic Analysis Radial plot, p^* is approximately 4,308 psia at the perforation midpoint.

Date reservoir pressure was last stabilized: Reservoir pressure was stabilized prior to initial injection operations in May 2013, 16 months before the current falloff test.

Justified Interval Thickness: The total perforated completion interval of 199' was utilized as the interval thickness.

16) Waste Plume

Cumulative injection volume into completed interval: 4,744,893 bbls as of Oct 1, 2014 at 12:00 AM. The cumulative volume provided by the operator was the EPA reported injection volumes through September 2014. Initial injection operations began in May 2013.

Average historical waste fluid viscosity: some surface condition viscosities have been measured and comport well with correlation data. All of the waste fluid injected into the ECCV DI-1 has been reverse osmosis (RO) brine produced as a result of treating ground water, which does not have a significant contrast to the formation waters. Waste plume viscosity is assumed to be the same as formation fluid viscosity.

Calculated radial distance to the waste front: The waste volume injected through September 2014 is 4,744,893 bbls. Assuming piston displacement and no significant contrast in viscosity between the formation water and the waste water, the radius of the waste plume is approximately 871'.

Equation:

$$r_{inj} = \sqrt{\frac{5.615 \cdot V \cdot B_w}{\pi \cdot h \cdot \phi}} = \sqrt{\frac{5.615 \cdot 4,744,893 \cdot 1.069}{199 \cdot 0.06 \cdot \pi}} = 871'$$

where $V = 4,744,893$ bbls, $B_w = 1.069$ rb/stb, $h = 199'$, $\phi = 0.06$.

Note that no upper limit for injected waste volume was set for the ECCV DI-1 well.

17) Injection Period

Time: 03:12:00 PM 09/30/14 to 04:03:00 PM 10/03/14, 72.883 hours, 24,923.5 bbls

Type fluid: Reverse osmosis (RO) brine

Pump type: Water plant injection pump

Flowmeter: Endress+Hauser Promag 53W Electromagnetic Flowmeter

Final injection pressure @ surface: 1,255.07 psi



Final injection pressure @ 9,595' mid-perf: 5,233.02 psia (calculated)
Final injection temperature @ surface: 49.20° F

18) Falloff Period

Total shut-in time: 04:03:00 PM 10/03/14 to 01:59:00 PM 10/15/14, 285.95 hours

Final shut-in pressure @ surface: 527.73 psi
Final shut-in pressure @ 9,595' mid-perf: 4,600.16 psia (calculated)
Final shut-in temperature @ surface: 54.57°F

19) Pressure Gradient

Since measurements were at surface, no static gradient was available for this test. Fluid level was at surface as evident from the positive pressure at the wellhead during the test.

21-22) Calculated Test Data and Corresponding Graphs

Please see attached graphs of the current test:

Data Chart	(Rate & Calculated Bottom Hole Pressure vs Time)
Diagnostic Analysis	(Log-Log Typecurve)
Diagnostic Analysis	(Radial Semi-Log Analysis)

The Rate, Tubing Pressure, Annular Pressure & Temperature vs Time plot shows surface injection pressure had essentially stabilized after the 73 hour injection period at 1,288 psig. No pressure anomalies due to gauge temperature de-stabilization are evident during the test. Data quality appears good during the test.

The Diagnostic Analysis (Typecurve) shows that a short radial flow period was reached approximately 67 hours into the falloff portion of the test. Analysis of this region gives a system permeability of 3.99 md with a skin factor of -6.78.

Using the permeability value calculated from the falloff period, we can calculate a radius of investigation from the falloff test as follows for t = 285.95 hrs, with other parameters as defined above:

$$r_i = \sqrt{\frac{kt}{948\phi\mu c_i}} = \sqrt{\frac{3.99 \cdot 285.95}{948 \cdot .06 \cdot 0.1947 \cdot 6.726 \times 10^{-6}}} = 3,913.72'$$

Radius of investigation = 3,913.72

Plots were generated using the Saphir software package available from Kappa Engineering, Paris, France. A .ks3 data file is included on the attached CD.

22) Comparison with Petition Demonstration

It is our opinion that the current test design is adequate to investigate this reservoir. We recommend that subsequent tests follow this same design.

23) Radioactive Tracer Survey

To date, no radioactive tracers have been run in this well.



24) Unusual Permit Approval Conditions

We are not aware of any unusual permit approval conditions.

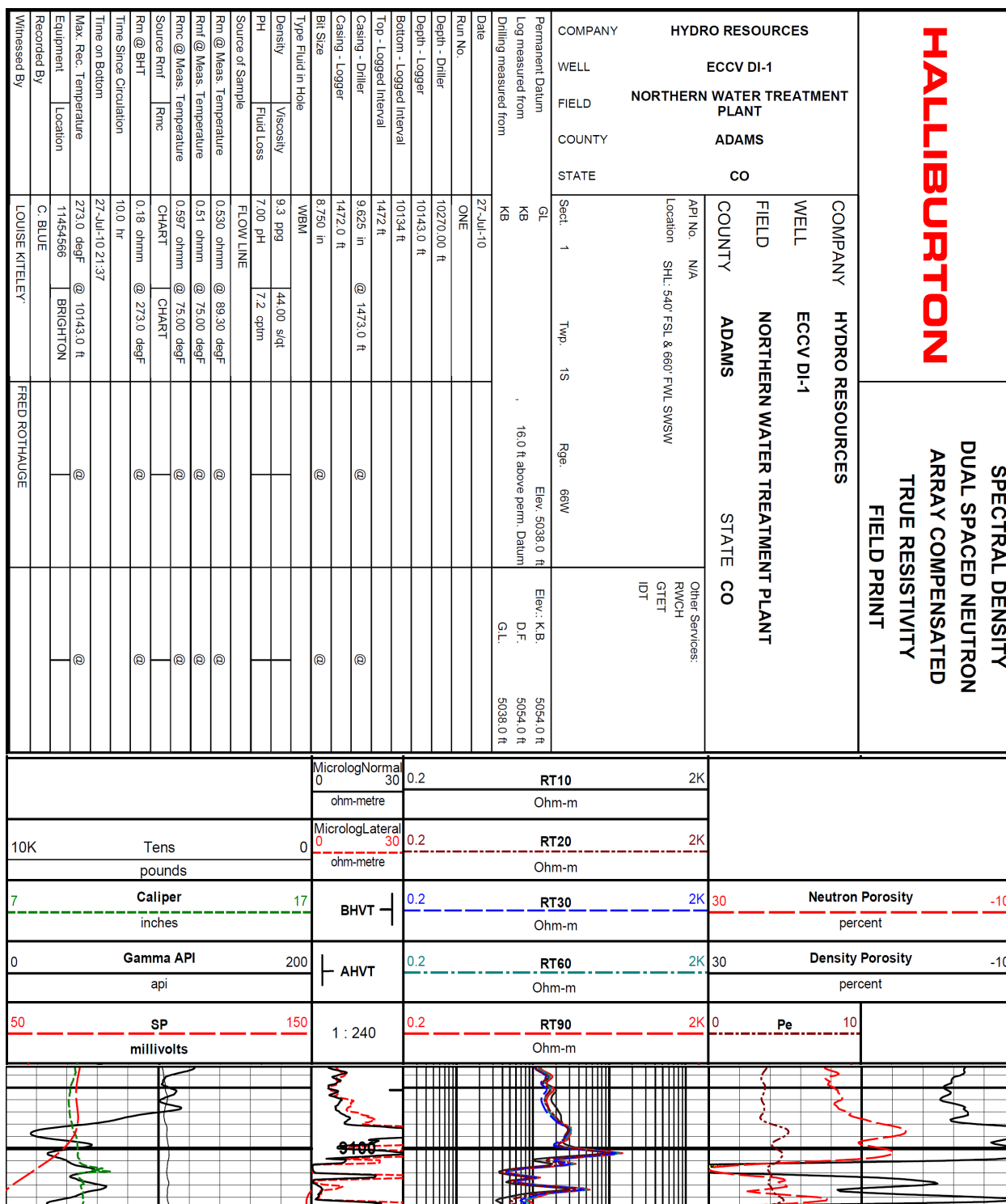


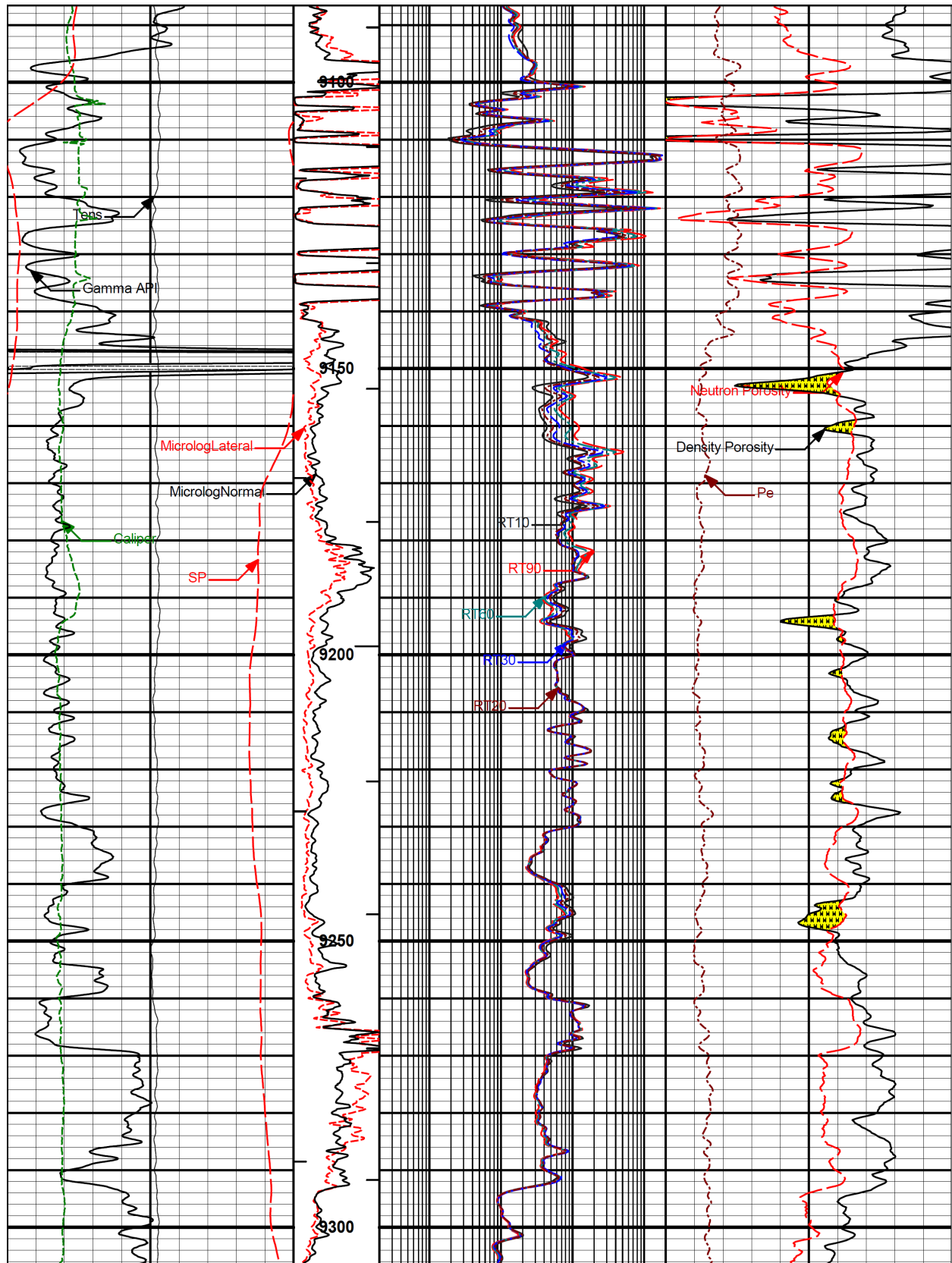
Report prepared for East Cherry Creek Valley Water and Sanitation District by

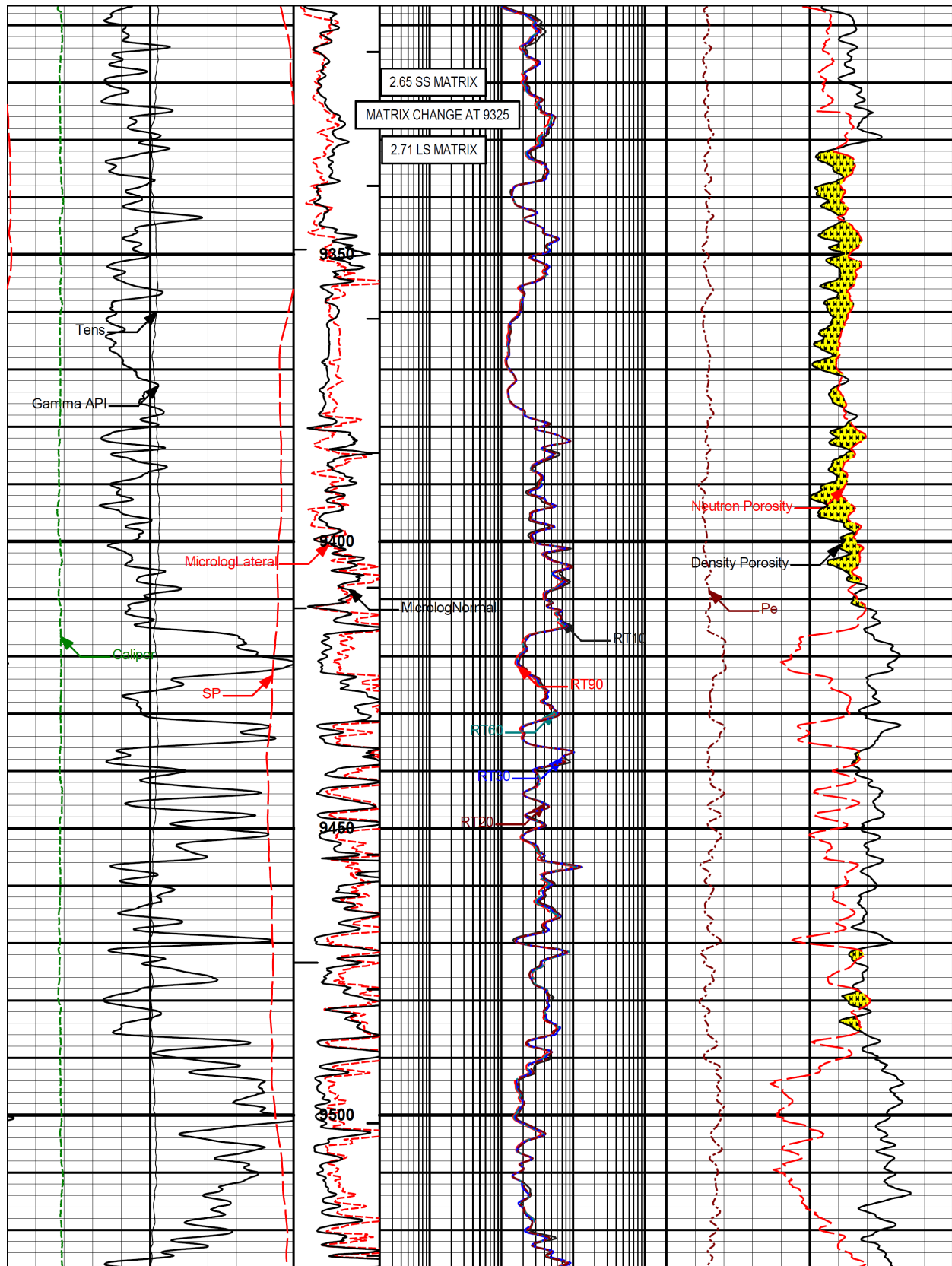
Integrated Petroleum Technologies, Inc.

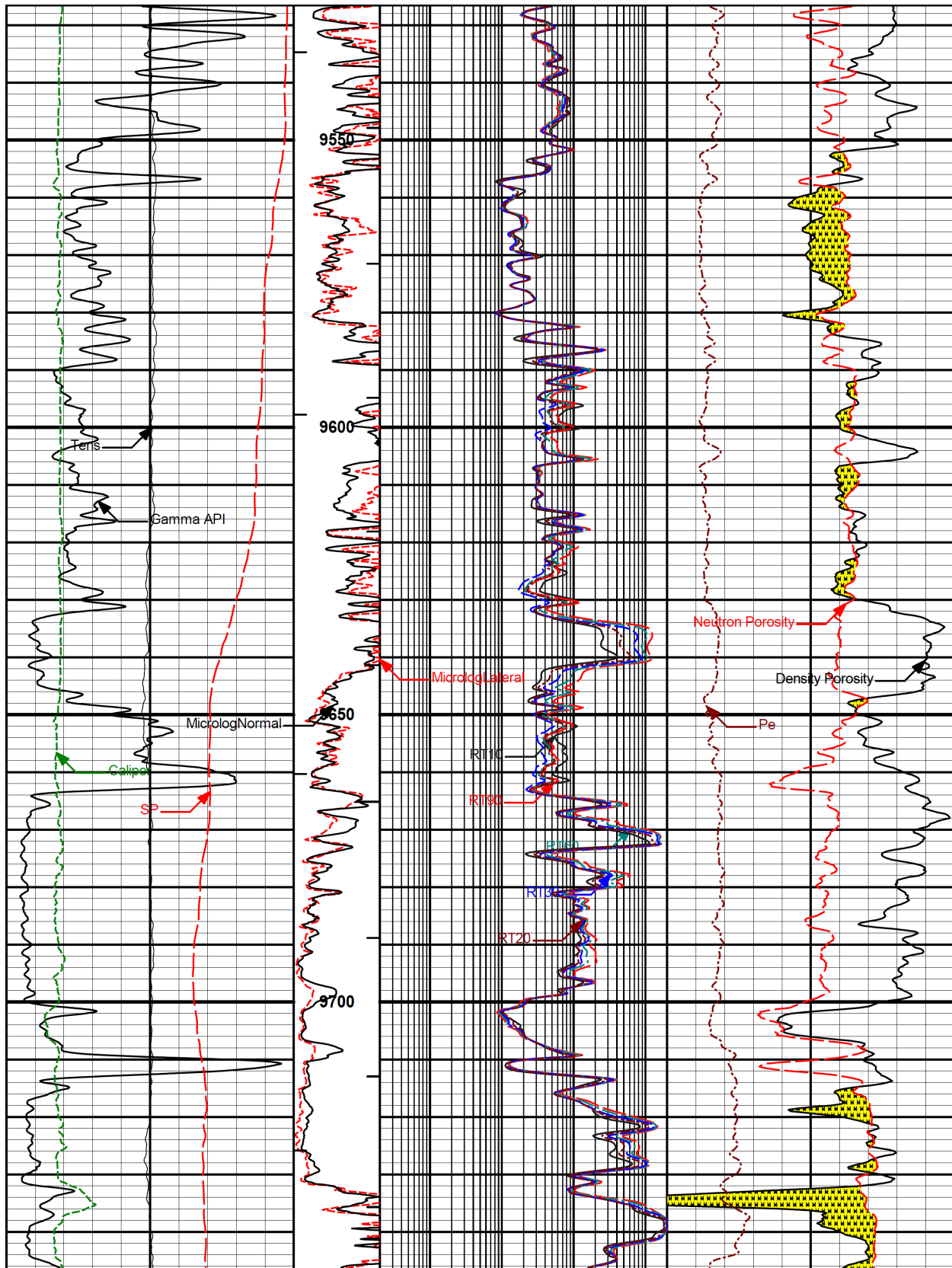
Clayton L. Doke
November 3, 2014

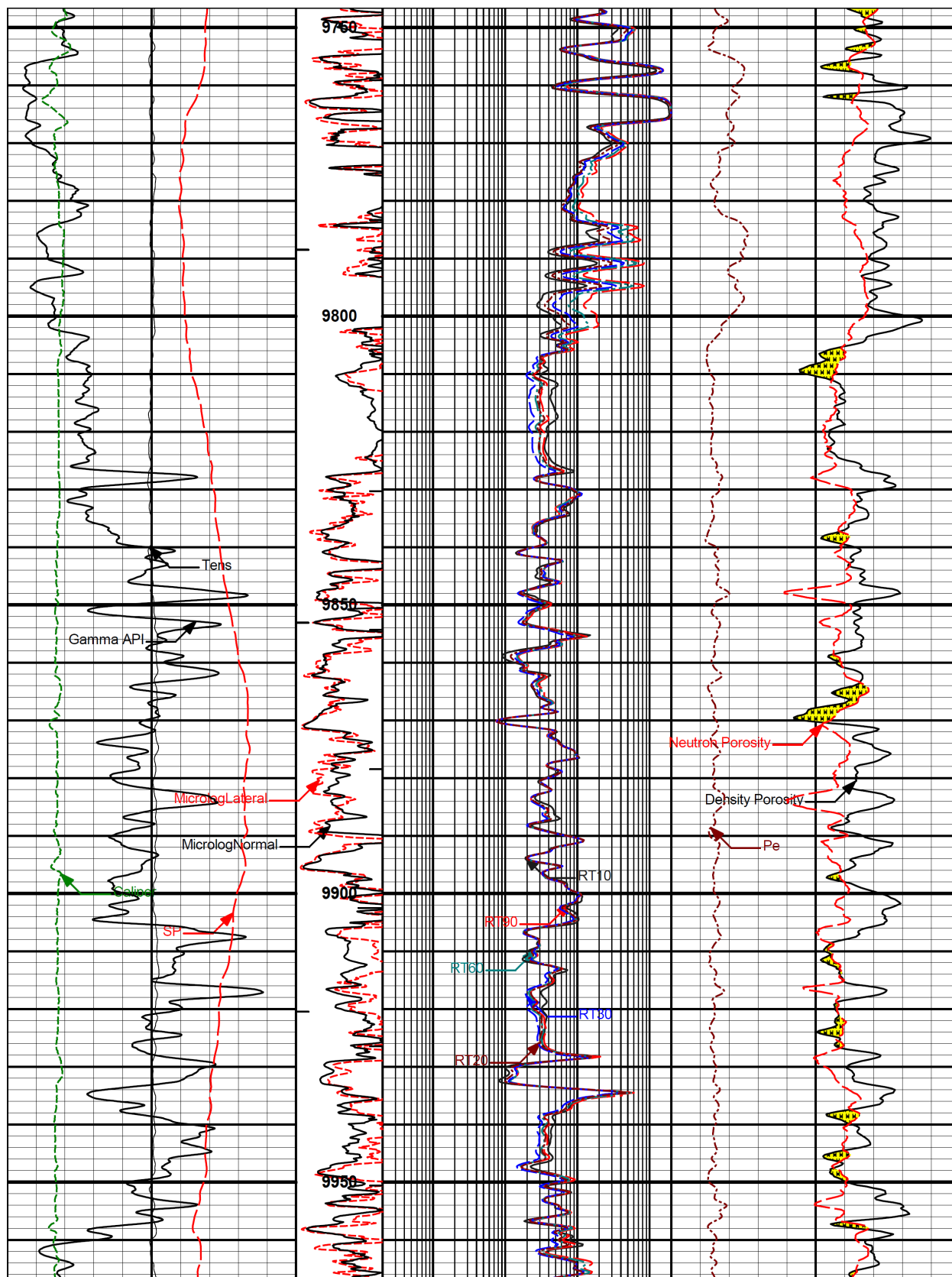
Reference: EPA Region VI UIC Pressure Falloff Testing Guideline, Third Revision, August 8, 2002

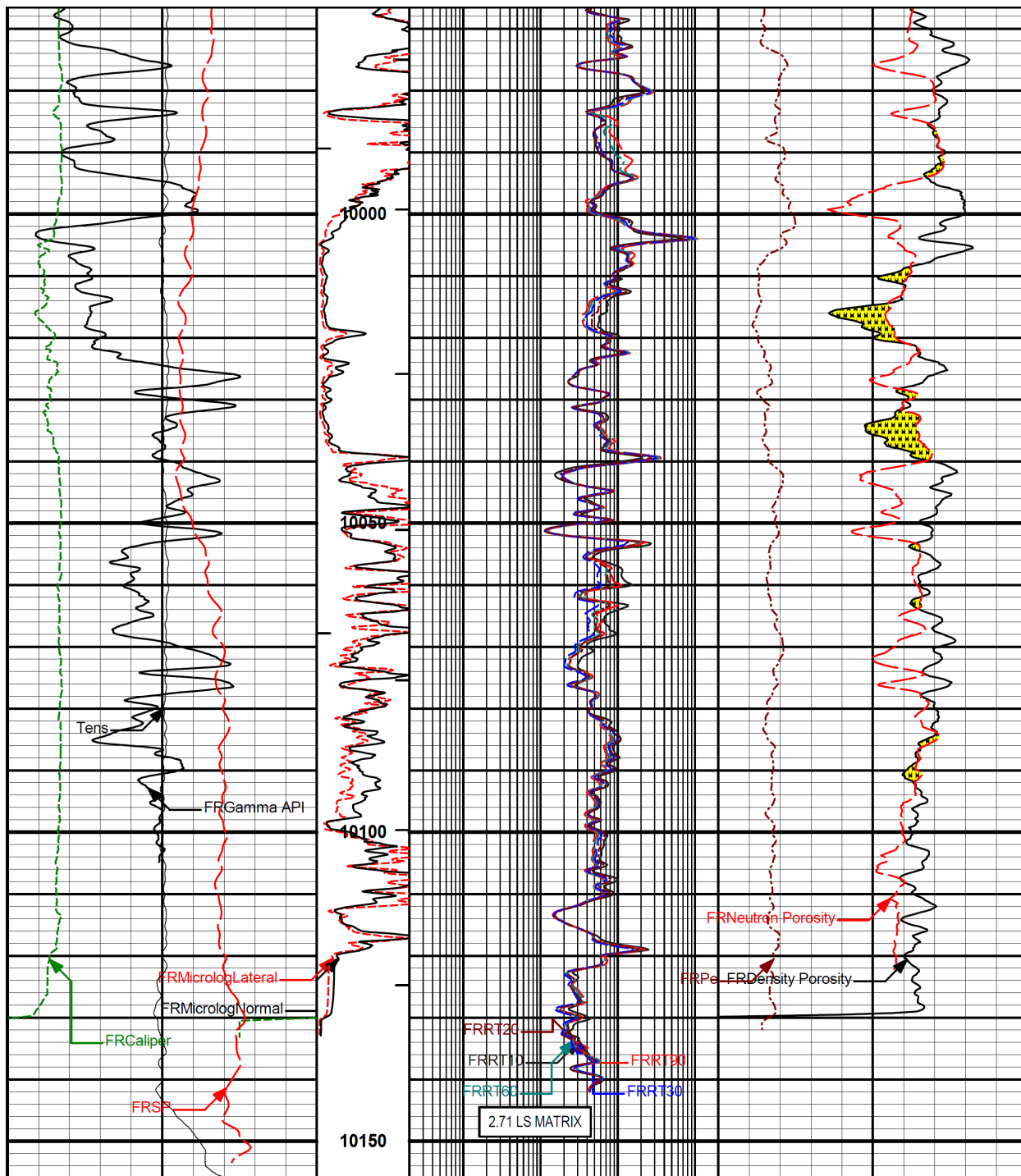














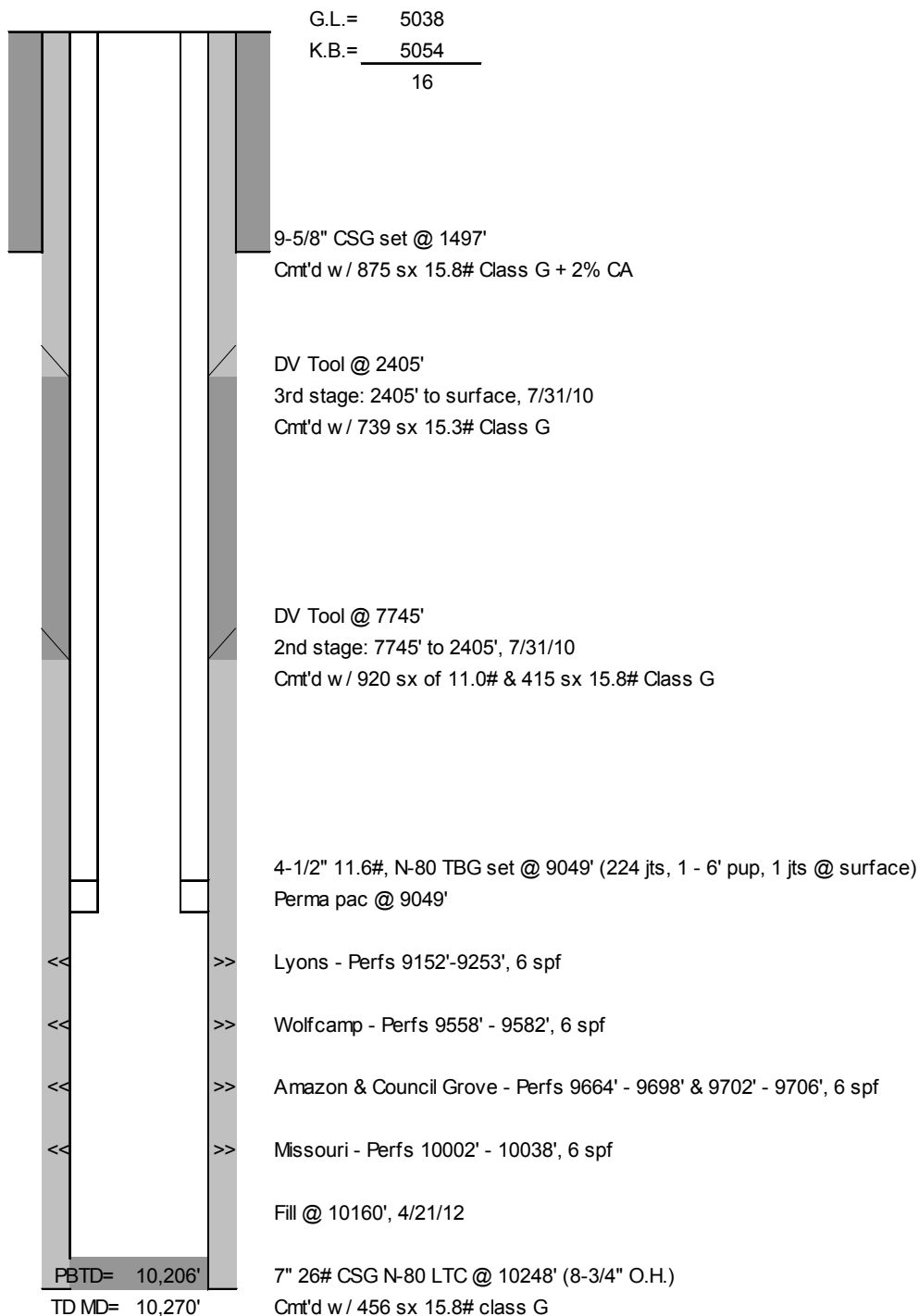
WELLBORE DIAGRAM

ECCV Water and Sanitation District

ECCV DI-1

SWSW 1-T1S-R66W
 SHL: 540' FSL, 660' FWL
 Adams County, Colorado
 EPA Class 1 Injection Well

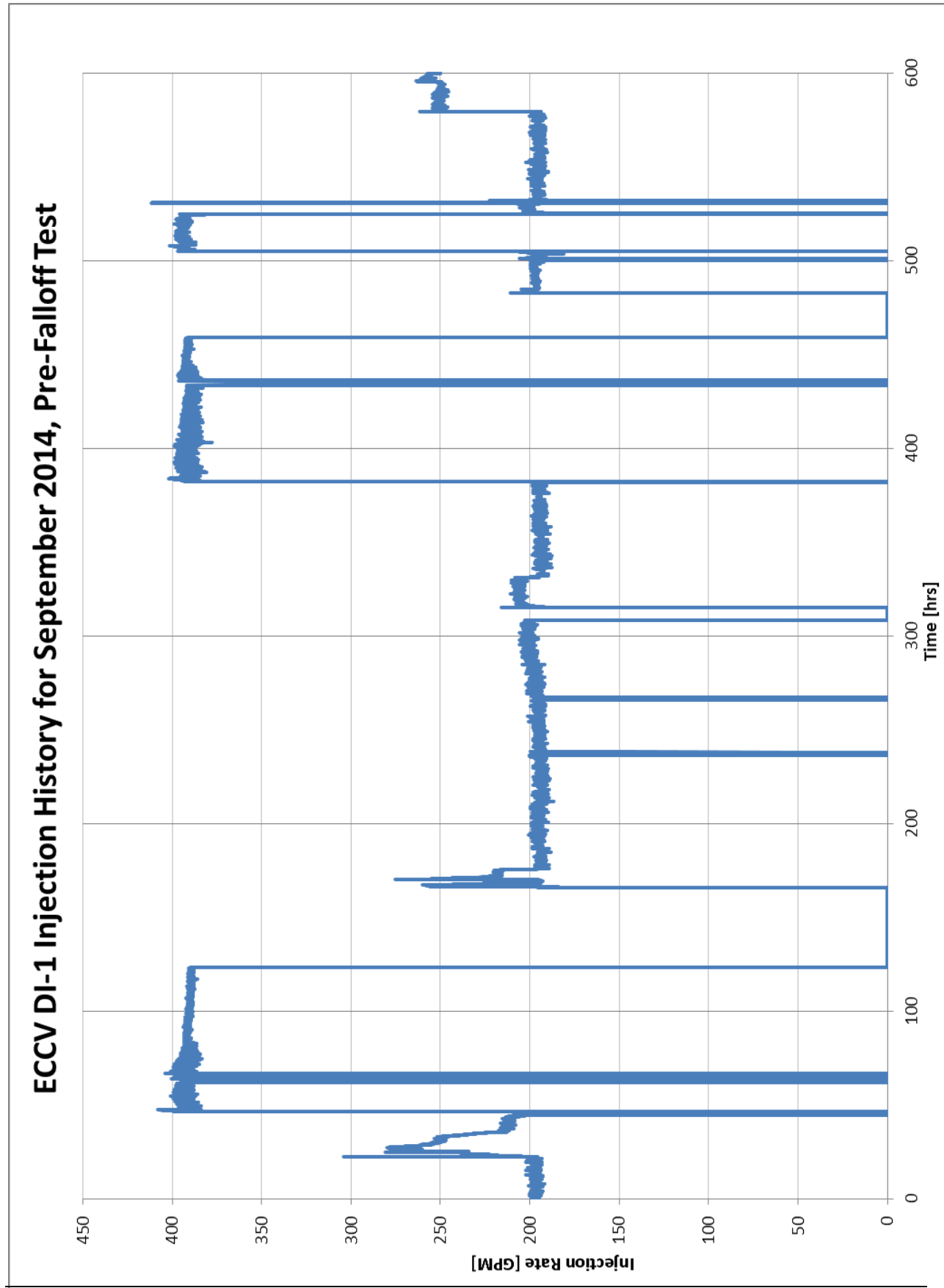
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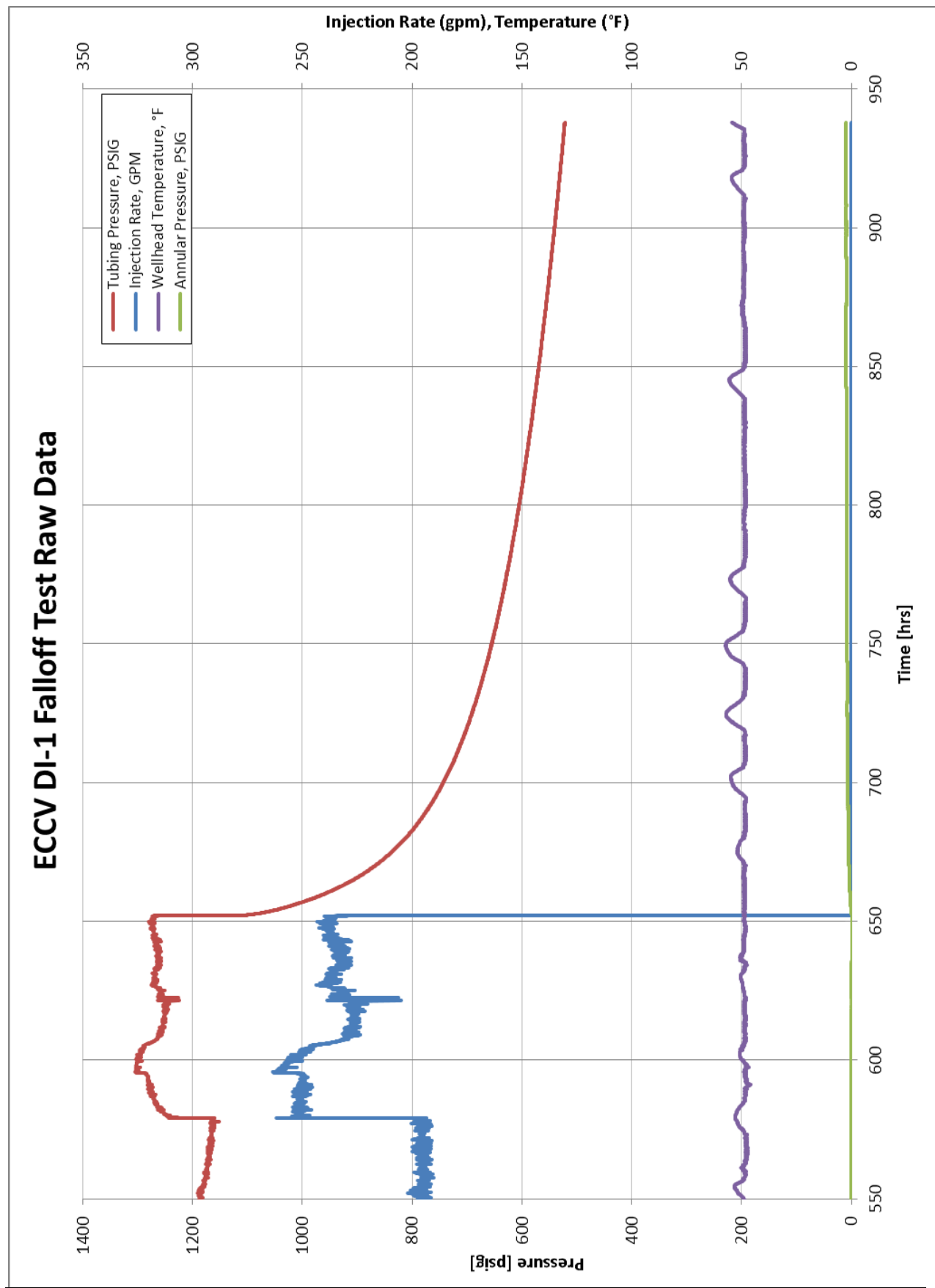




ECCV DI-1 Injection History Summary, Pre Falloff Test
Oct 2014

START TIME	END TIME	RATE (bwpd)	INC. HOURS (hrs)	INC. VOLUME (bbls)	CUM. HOURS (hrs)	CUM. VOLUME (bbls)
10/6/14 12:00 PM	10/8/14 8:31 AM	7393	44.52	13712.99	44.5	13712.98819
10/8/14 8:31 AM	10/8/14 10:19 AM	0	1.80	0.00	46.3	13712.98819
10/8/14 10:19 AM	10/9/14 3:03 AM	12998	16.73	9062.49	63.0	22775.48264
10/9/14 3:03 AM	10/9/14 3:38 AM	0	1.46	0.00	64.5	22775.48264
10/9/14 3:38 AM	10/9/14 5:06 AM	11748	1.47	717.93	66.0	23493.41597
10/9/14 5:06 AM	10/9/14 6:30 AM	0	1.40	0.00	67.4	23493.41597
10/9/14 6:30 AM	10/11/14 3:04 PM	13382	56.57	31540.63	123.9	55034.04653
10/11/14 3:04 PM	10/13/14 9:53 AM	0	42.82	0.00	166.8	55034.04653
10/13/14 9:53 AM	10/22/14 9:41 AM	6717	215.80	60397.02	382.6	115431.0715
10/22/14 9:41 AM	10/22/14 9:58 AM	0	0.28	60397.02	382.8	115431.0715
10/22/14 9:58 AM	10/25/14 3:11 AM	13366	65.22	36320.25	448.1	151751.3201
10/25/14 3:11 AM	10/26/14 2:41 PM	0	35.50	0.00	483.6	151751.3201
10/26/14 2:41 PM	10/28/14 8:37 AM	13443	41.93	23487.91	525.5	175239.2285
10/28/14 8:37 AM	10/28/14 9:16 AM	0	0.65	0.00	526.1	175239.2285
10/28/14 9:16 AM	10/30/14 3:08 PM	6694	53.87	15024.31	580.0	190263.5396







Calibration Certificate Process Pressure

Endress+Hauser 

People for Process Automation

Certificate n° **HAG1358SW**
Calibration date **10/16/2014**

Customer information

Company name **East Cherry Creek Valley**
Address **21850 I-76 Frontage Rd**
Code City **80603 Brighton**

Place of calibration

Company name **East Cherry Creek Valley**
Address **21850 I-76 Frontage Rd**
Code City **80603 Brighton**
Contact person **Clint Carter**

Instrument information (UUT)

UUT : Unit Under Test

Instrument (UUT) **PMP71-SBC1W61RDANA**
Serial n° **E904681509C**
Instrument Loc. **Well house**
Manufacturer **Endress+Hauser**
Tag n° **PIT-27410**

Measuring range **0 to 6000 psi gauge**

Calibration range **0 to 2860 psi gauge**

Standards used

Description	Serial n°	Certificate n°	Due date
Fluke 753 Process Calibrator	1777077	5-CG0BK-1-1	12/4/2014
Fluke 700PD8 1000Psi Pressure Module	89550810	15-CU2PN-3-1	9/9/2015

Calibration Method

SOP_C_en_PZ
Standard Operating Procedure for Calibration on site of pressure measurements

Environmental conditions

Ambient temperature **24 ± 3 °C**

Calibration value As Found

Test Point	Reference Value	Display Value UUT	Output UUT	Deviation*	+/- MPE
	psi gauge	psi gauge	psi gauge	psi gauge	psi gauge
1.0	0.00	0.00		0.00	30.00
2.0	1800.00	1801.00		1.00	30.00
3.0	2860.00	2859.00		-1.00	30.00

* (Maximum) Deviation to 'Reference value'

Calibration Point not conform

Conformity

☒ UUT conform ☐ UUT not conform

Remarks

Measurement works within the specification
Unable to reach 6000psi due to air in the lines that could not be evacuated

This calibration certificate documents the traceability to national standards, which states the units of measurement according to the International System of Units (SI). This calibration certificate meets the requirements of the ISO/IEC 17025 standard. It should not be published or reproduced other than in full.


Service Technician **Sam Walker**
Signature

Customer: **Clint Carter**
Signature

Printing date **10/16/2014**



Calibration Certificate Process Pressure

Endress+Hauser 
People for Process Automation

Customer information

Company name East Cherry Creek Valley
Address 21850 I-76 Frontage Rd
Code City 80603 Brighton

Certificate n° HAG1358SW
Calibration date 10/16/2014

Place of calibration

Company name East Cherry Creek Valley
Address 21850 I-76 Frontage Rd
Code City 80603 Brighton
Contact person Clint Carter

Instrument information (UUT)

UUT : Unit Under Test

Instrument (UUT) PMP71-SBC1S61RAANA
Serial n° F400031509C
Instrument Loc. Well house
Manufacturer Endress+Hauser
Tag n° PIT-27415

Measuring range 0 to 200 psi gauge
Calibration range 0 to 200 psi gauge

Standards used

Description	Serial n°	Certificate n°	Due date
Fluke 753 Process Calibrator	1777077	5-CG0BK-1-1	12/4/2014
Fluke 700PD8 1000Psi Pressure Module	89550810	15-CU2PN-3-1	9/9/2015

Calibration Method

SOP_C_en_PZ
Standard Operating Procedure for Calibration on site of pressure measurements

Environmental conditions

Ambient temperature 24 ± 3 °C

Calibration value As Found

Test Point	Reference Value	Display Value UUT	Output UUT	Deviation*	+/- MPE
	psi gauge	psi gauge	psi gauge	psi gauge	psi gauge
1.0	0.00	0.00		0.00	1.00
2.0	100.00	100.30		0.30	1.00
3.0	200.00	200.20		0.20	1.00

*(Maximum) Deviation to 'Reference value'

Calibration Point not conform

Conformity


☒ UUT conform

☐ UUT not conform

Remarks

Measurement works within the specification

This calibration certificate documents the traceability to national standards, which states the units of measurement according to the International System of Units (SI). This calibration certificate meets the requirements of the ISO/IEC 17025 standard. It should not be published or reproduced other than in full.


Service Technician Sam Walker
Signature

Customer: Clint Carter
Signature

Printing date 10/16/2014



DTM Version: 3.22.00

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Flowmeter Verification Certificate Transmitter

East Cherry Creek Valley Water

Customer

53W1F-ULGB1AC0BAAL

Order code

PROMAG 53 WDN150

Device type

EA06FA16000

Serial number

V2.03.00

Software Version Transmitter

10/16/2014

Verification date

Brighton

Plant

FIT27400

Tag Name

1.0218 - 1.0218

K-Factor

1

Zero point

V1.05.03

Software Version I/O-Module

10:14 AM

Verification time

Verification result Transmitter: Passed

Test item	Result	Applied Limits
Amplifier	Passed	Basis: 0.55 %
Current Output 1	Passed	0.05 mA
Test Sensor	Passed	

FieldCheck Details

139525

Production number

1.07.04

Software Version

07/2014

Last Calibration Date

Simubox Details

8743937

Production number

1.00.01

Software Version

07/2014

Last Calibration Date

10/16/2014

Date

Sam Walker
Operator's Sign

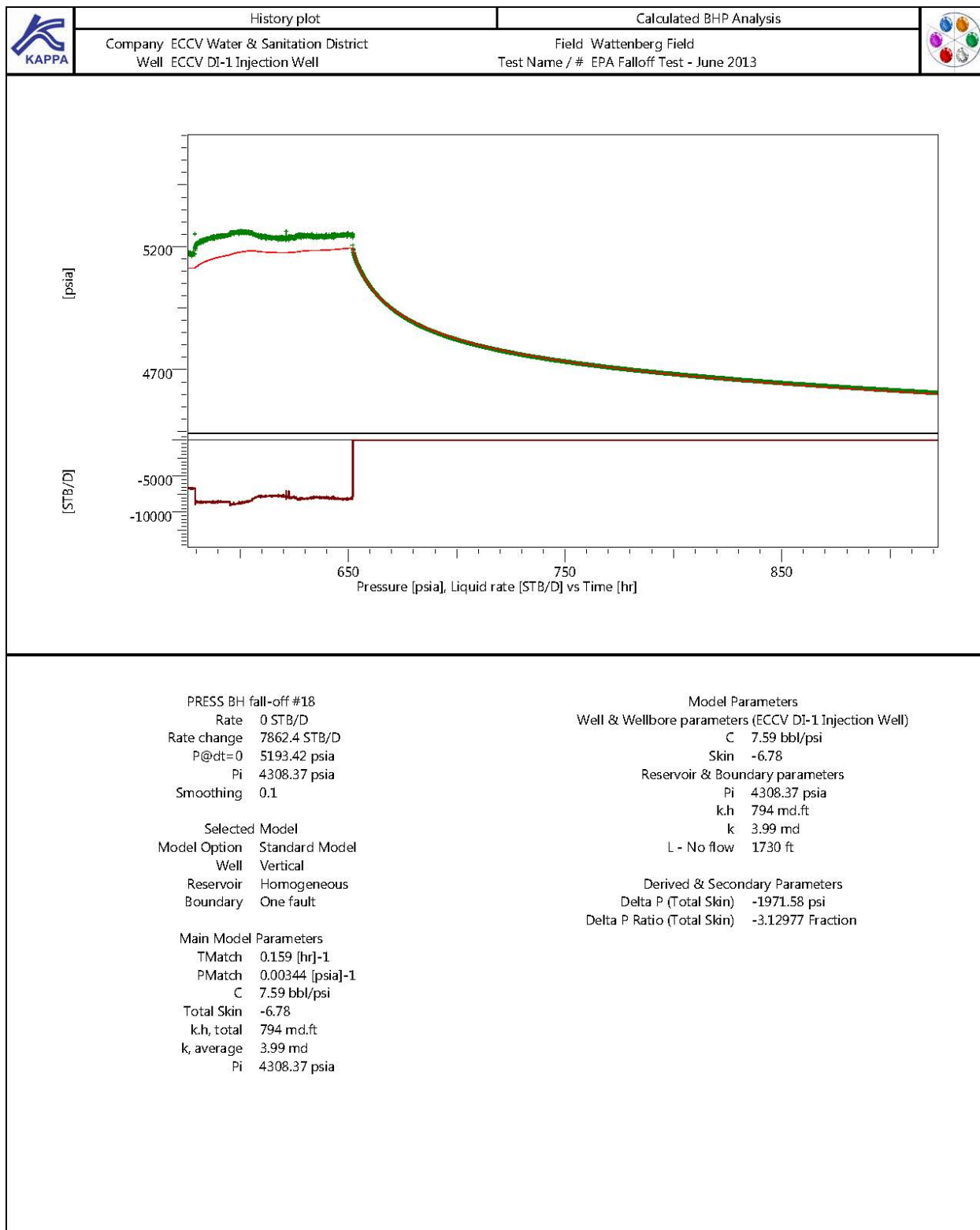
Inspector's Sign

Overall results:

The achieved test results show that the instrument is completely functional, and the measuring results lie within +/- 1% of the original calibration.¹⁾

The calibration of the Fieldcheck test system is fully traceable to national standards.

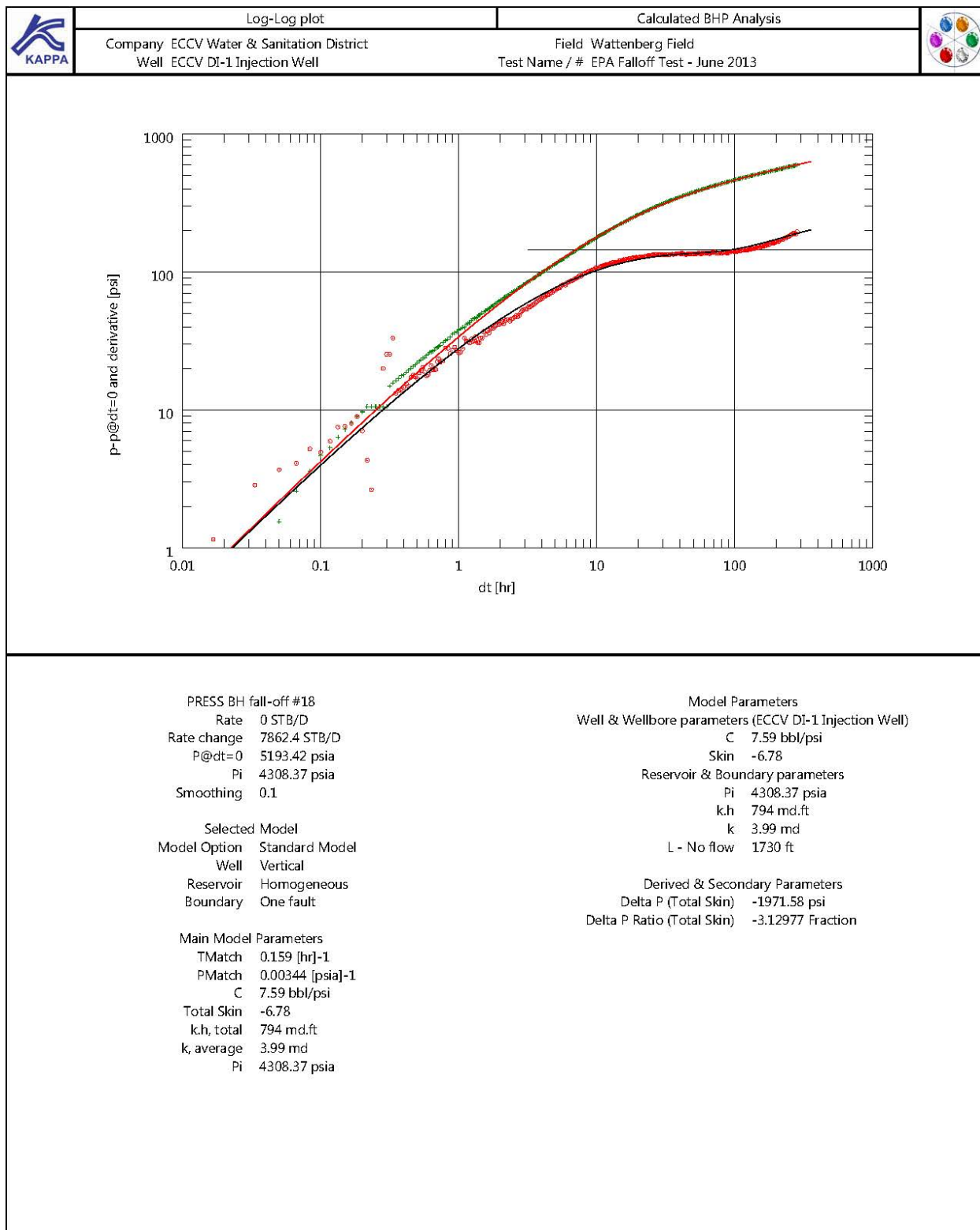
Endress+Hauser 



ECTM v430.07 ECCV-DI-1_EPA_Falloff_Test_Rev 2.1a3

11/6/2014

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